

## **APPENDIX E**

### **Draft Preliminary Work Plan for Pulsed Air Biosparging Pilot Test**

## **DRAFT PRELIMINARY WORK PLAN FOR PULSED AIR BIOSPARGING PILOT TEST**

Sauget Area 1 Feasibility Study

### **1.0 OVERVIEW**

This conceptual Pulsed Air Biosparging System Work Plan is submitted only as additional information for Alternative 5 as set out in the RI/FS. It is anticipated that this draft Plan would be used as an initial step in the RD/RA process only if U.S. EPA finds Pulsed Air Biosparging to be a reasonable and appropriate remedy at the Sauget Area 1 Sites.

A Pulsed Air Biosparging System (PABS) is being considered for in-situ treatment of the DNAPL residual areas in the Middle Hydrogeologic Unit (MHU) and Deep Hydrogeologic Unit (DHU) at Sauget Area 1 Sites G, H, and I South. The conceptual PABS system would be operated in an intermittent fashion, with high flow rate pulses of atmospheric air. This method of subsurface oxygen delivery will ensure proper gas distribution, reduce volatilization of contaminants, and eliminate the need for costly soil vapor extraction systems and the associated vapor treatment systems.

To evaluate the feasibility and effectiveness of a full-scale PABS system, a pilot test will be conducted to determine operational parameters, measure performance characteristics, and estimate the necessary spacing of sparge wells for a full-scale PABS system. The test will include the following activities:

- Baseline characterization sampling of soil and groundwater
- Installation of biosparging wells, passive vent wells, and groundwater monitoring wells
- Construction and installation of PABS system and piping
- PABS system pilot test operation and groundwater sampling (12 months)
- Post-test soil and groundwater sampling

### **2.0 SPARGING AND MONITORING WELL LAYOUT AND SYSTEM INSTALLATION**

The pilot test system will be located at Site I South and will consist of four sparging locations, each containing two nested injection wells targeting the MHU and DHU and a passive vent well screened in the SHU and upper few feet of the MHU. The four sparging locations will be spaced approximately 60 feet apart in an offset grid (see Figure E.1). The wells will be drilled and installed using Rotasonic drilling techniques. Each biosparging well will consist of a 2-inch diameter stainless steel well with a 2-ft long wire-wrapped screen. Biosparge wells will be completed with a sand filter pack around the well screen, a hydrated bentonite seal placed atop the filter pack, and a cement/bentonite grout surface seal installed from above the filter pack seal to ground surface. Screened intervals will be placed at approximately 70 feet and 100 feet bgs in the MHU and DHU respectively. Particular attention will be paid to well construction to ensure that short circuiting of air along the annular space does not occur during system operation.

A network of groundwater monitoring wells will be installed to assess the performance of the PABS pilot test. Nested monitoring wells (MHU and DHU) will be installed at 10 locations at the approximate locations shown on Figure E.1. The wells will be installed to depths targeting the MHU and DHU. The wells will be constructed of 2-inch diameter flush-threaded stainless steel pipe with pre-packed screens, 5 to 10 feet in length, and a flush-threaded bottom cap. Wells will be completed with a filter pack seal (e.g., bentonite), concrete surface seal, pad, and manhole cover, and expandable well cap. At each location the monitoring wells will be installed to a depth that approximates the target treatment zones within the MHU and DHU.

The pilot test system will include a biosparge skid that houses all above-ground components for operating the system. The skid will contain all necessary safety interlocks and alarms, such as pressure relief valves and emergency stop, to insure safe operation of the system. A continuous on-site electric power supply will need to be arranged prior to test startup. A compressor will be used to deliver atmospheric air to the 8 sparging wells via a manifold equipped with flow meters and pressure gauges for monitoring each injection line. Air will be delivered to each well in short duration, high flow rate pulses, and regulated using timer-activated solenoid valves. As the pilot test system will be operated on an intermittent basis (pulsed air injections) one compressor will be sufficient for operating the 8 injection wells (4 nested biosparge locations). The four passive vent wells will be connected via a manifold to a single drum of vapor phase granular activated carbon located next to the biosparge skid.

### **3.0 PILOT TEST OPERATION AND SAMPLING**

#### **3.1 Pilot Test System Optimization and Operation**

The pilot test will be conducted for 12 months, and will consist of a startup phase of approximately 1 month, and an operation phase of approximately 11 months. During the startup phase, the system will be monitored closely and operating parameters will be varied in order to determine the optimal configuration for the remaining operating period. Initially, sparging of the eight wells will be performed twice per week for approximately three hours. The parameters that will be optimized during the startup phase include: sparge volume, injection pressure, flow rate, sparge frequency and duration necessary for appropriate subsurface gas distribution.

Air (oxygen) distribution will be assessed primarily by measuring dissolved oxygen in groundwater, and operating parameters will be adjusted accordingly ensure effective dissolved oxygen distribution. After the initial one-month optimization period the pilot test will be continued for approximately 11 months to characterize the performance as relating to the treatment of the DNAPL residual areas.

## **3.2 Sampling and Monitoring**

Groundwater sampling will be conducted prior to and during the pilot test to evaluate the distribution of dissolved oxygen and changes in contaminant concentrations over time at the test area. Pre-test and post-test soil sampling will be conducted to assess contaminant mass removal at the test area. The groundwater and soil sampling are described in more detail below.

### **3.2.1 Groundwater Sampling**

Groundwater samples will be collected prior to startup of the pilot test and regularly during the operation of the system. The objective of the groundwater monitoring program will be to assess dissolved oxygen distribution and to establish that degradation of key VOCs and SVOCs (e.g., chlorobenzene, 1,4-dichlorobenzene, benzene, and 4-chloroaniline) is occurring as a result of biosparging. Samples will be collected using low-flow sampling techniques, placed in laboratory-approved containers, stored on ice, and shipped under chain-of-custody control to a commercial laboratory for analysis of VOCs (including dichlorobenzenes) and SVOCs. Analysis of dissolved oxygen (DO) and CO<sub>2</sub> will be done in the field using meters equipped with compound-specific probes (for DO) or test kits (for CO<sub>2</sub>).

An initial groundwater sampling event will be conducted prior to the startup of the PABS pilot system to establish the baseline conditions within the pilot test area. Samples (including 15% duplicates) will be collected from each well installed within the treatment area. Adjustments to the sampling frequency will be made as appropriate based on on-going data evaluations. It is anticipated that monthly sampling and analysis of VOCs and SVOCs will be conducted for the first 6 months of system operation. After 6 months, the sampling frequency will be decreased to quarterly events until the conclusion of the test. Duplicate samples will be collected for 15% of the samples for a total of approximately 184 ground water samples analyzed (160 plus 24 duplicates).

Because effective performance of the PABS technology relies on biological oxygen utilization, oxygen distribution will be measured frequently by field personnel during the startup period. Dissolved oxygen will be measured daily with portable instruments during the first two weeks of the test. During the next two weeks, DO concentrations will be measured prior to and after each air sparge event (i.e., twice per week). Thereafter DO concentrations will be measured once per month.

### **3.2.2 Soil Sampling**

Baseline soil concentrations in the MHU and DHU will be determined via soil samples collected during installation of the groundwater monitoring wells. Soil samples will be collected from within the MHU and DHU at four to five foot depth intervals such that approximately 14 samples (8 from MHU and 6 from DHU) will be obtained from each monitoring location. Approximately 161 soil samples (140 plus 21 duplicate samples) will be collected from within the pilot test treatment area. All soil samples will be analyzed for VOCs (including dichlorobenzenes) and SVOCs in accordance with EPA Methods 8260 and 8270.

After completion of the biosparging pilot test, a second series of soil samples will be collected from soil borings installed immediately adjacent to the monitoring wells. Sample depth intervals will correspond to the depth intervals sampled and tested before the pilot test. Sampling and testing methods will be the same as those used in the pre-pilot test sampling event. As with the baseline sampling 161 soil samples will be analyzed during this phase.

Comparison of the data from the two tests will provide a means to assess system performance (e.g., mass removal). To reduce the variability inherent in collection of discrete depth soil samples, an appropriate statistical procedure (e.g., mean or geomean, depending on the data distribution) may be used to calculate representative pre- and post-treatment concentrations for purposes of evaluating mass removal. The following table summarizes the anticipated groundwater and soil sampling before, during, and after the pilot test.

**Anticipated number of groundwater and soil samples for PABS pilot test**

<b>Project Phase</b>	<b>Groundwater</b>	<b>Soil</b>
Pre-Startup (Baseline)	23	161
Startup (Weeks 1-4)	--	--
Routine Monthly Sampling (Months 1-6)	115	--
Routine Quarterly Sampling (Months 6-12)	46	--
Post-Operation	--	161
<b>Total</b>	<b>184</b>	<b>322</b>

#### **4.0 PILOT TEST REPORT**

A report will be prepared to discuss results of the pilot test and present key findings for the design of a full-scale PABS system such as observed zone of oxygen influence, well spacing, optimum pulse duration and intensity, and compressor capabilities.

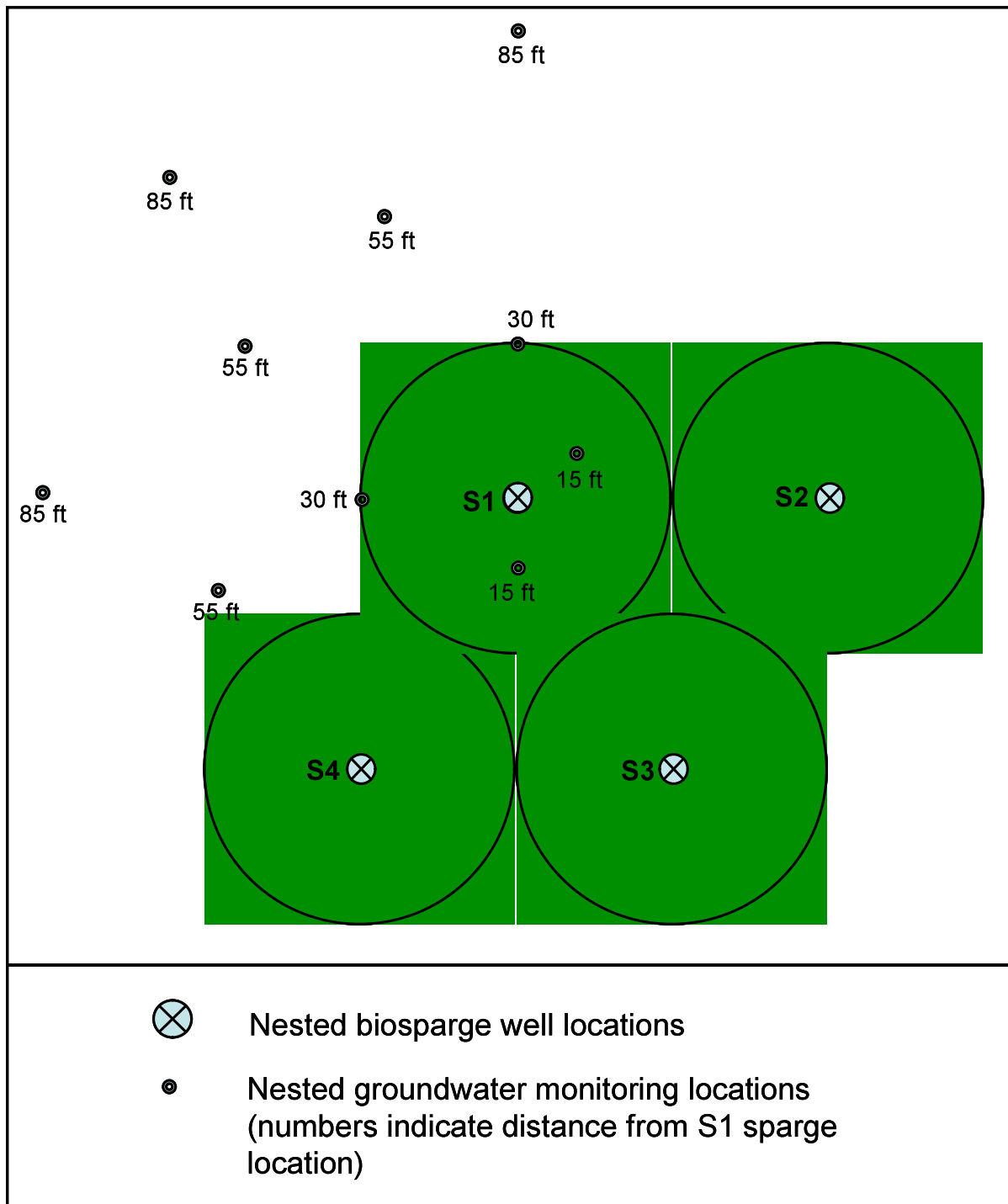


Figure E.1: Pulsed air biosparging pilot test well layout.